Wärtsilä Smart Power Generation

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The world demands

DESIRED FUTURE OF POWER SYSTEMS

- Affordable
- Reliable
- Smart Power System
- Sustainable
Load variations in power systems

- **Base load**
  - Constant generation 24/7/365
  - Nuclear and coal plants
- **Intermediate load**
  - Normal daily load variations
  - Increase of wind and solar power introduce uncertainty which leads to large generation variations
- **Peak load**
  - Covering high demand hours
- **Regulation**
  - Balancing the system (frequency & voltage)
- **Reserves**
  - Contingency situations
Growing challenges for power systems

- Variability of generation, intermittency
  - Increasing wind and solar production
- Forecasting error
  - Intermittent generation
- Increasing demand variations
  - Electricity intensity and less industrial production
- Power plant commitment
  - Inflexible generation

INCREASING DEMAND FOR FLEXIBLE POWER GENERATION
The perfect match
Case study: Smart wind chasing in Colorado, US

PLAINS END POWER PLANT, COLORADO, USA

Type: Grid stability
Engines: 20 x Wärtsilä 18V34SG
14 x Wärtsilä 20V34SG
Total output: 227 MW
Fuel: Natural gas
Installed: 2002 and 2008

Remote controlled from Colorado Dispatch Center
FUTURE POWER PLANTS:

- Efficiency
- Starting & stopping times
- Ramp rate
- Part load operation
- Firm capacity

Operational flexibility AND electrical efficiency

**Electrical efficiency**

- **50%**
  - CCGT

- **40%**
  - Coal

- **30%**
  - Nuclear

**Flexibility**

- **Low**
  - Nuclear Power Plants
  - Steam Power Plants

- **Medium**
  - OCGT Industrial
  - Gas Turbine Plants: Open Cycle (OC) and Combined Cycle (CC)

- **High**
  - Wärtsilä Flexicycle™
  - Wärtsilä
  - Combustion Engine Plants
Fastest loading by Combustion Engine

POWER PLANTS:
- Wärtsilä Combustion Engine
- Open Cycle Gas Turbine (OCGT), industrial
- Open Cycle Gas Turbine (OCGT), aeroderivative
- Combined Cycle Gas Turbine (CCGT)
- Coal Fired
Wind generation is very variable, leading to periods of very high generation and low periods of very low generation.

Thermal plants will have to operate in a different manner, with lower load factors and higher risk.

Prices may become highly volatile and driven increasingly by wind generation.
Engines are more efficient across the operation range.

Average efficiency, start to stop

- Wärtsilä combustion engine
- OCGT Aero
- OCGT Industrial
- Wärtsilä Flexicycle
- CCGT

Efficiency %

OPERATION TIME:
- 8 hours
- 4 hours
- 2 hours
- 1 hour
High efficiency due to multiple units

Part load efficiency

Plant efficiency, % (net)

Plant output, %

- 5 units
- 6 units
- 7 units
- 8 units
- 9 units
- 10 units

10 x Combustion engine
1 x OCGT, aero
1 x OCGT, industrial

GT performances: GTPro by Thermoflow
High reliability due to multiple units

Wärtsilä’s 11 x 18V50SG

Firm capacity

Firm capacity?
True and lower cost of generation

Electricity generation cost
€/MWh

WÄRTSILÄ
Flexicycle plant:
256 MW
Combined Cycle
→ Gas Turbine plant:
225 MW

73.0
1.3 0.2 0.7
Ambient
15→25°C
Gas pressure
30 → 10 bar
Water treatment
Emission reduction
etc.

12.9
0.8 1.2 0.9
Altitude
0 → 300m
Degr. and aging,
output
degr. and aging,
efficiency

69.7
4.5 0.5 2.3
Running hrs
8000 → 4000
Running profile
Average load
100 → 80%

100.0 €/MWh
Δ10,5 €/MWh
89,5 €/MWh
30,3 €/MWh

1.3 0.2 0.7
Daily starts,
start-up fuel

13.6.2012

Daily starts,
Steam cycle maint.

Operation mode

0.8 1.2 0.9
Daily starts,
GT maint.

69.7
Running profile
Average load
100 → 80%

4.5 0.5 2.3
Performance
degradation

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Benefits to power producers

- Operation in different generation modes
- High efficiency
- Fuel flexibility
- Dependable and committable
  - Multiple generating units
- Operate on multiple markets
  - Energy markets
  - Capacity markets
  - Ancillary services markets
- Optimum plant location close to consumers
- Fast access to income through fast-track project delivery
- Competitive O&M costs
Benefits to power systems

- **Secures the supply of affordable and sustainable power**
  - Enable highest penetration of wind and solar power capacity
  - Maximising the use of wind power capacity by minimising wind curtailment
  - Ensure system stability in wind variability and contingency situations

- **Ensures true optimisation of the total power system operation**
  - Remove the abusive starts and stops, and cyclic load from baseload plants that are not designed for it
  - Improves the total system efficiency
Modularity and multi unit solution enable accurate plant size matching to the grid and the demand.
Matching changing requirements

**DESIRABLE FUTURE OF POWER SYSTEM**

- **Affordable**
- **Reliable**
- **Sustainable**

**WÄRTSILÄ’S OFFER**

- **Energy Efficiency**
- **Fuel Flexibility**
- **Operational Flexibility**
- **Smart Power Generation**